English translation of the
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Semi-rigid protective helmet

Background of the invention

The invention relates to a protective helmet comprising a deformable internal foam liner, a plurality of rigid external shell segments in the form of scales arranged on the foam liner so as to form at least one crown segment, at least one occipital segment and a plurality of transverse side segments, and joining means made of flexible material performing joining between the segments.

State of the art

Numerous sports or leisure activities require the use of a protective helmet. Generally, the helmet is relatively heavy, bulky, with a monoblock external shell to guarantee protection and safety to the detriment of the aesthetic appearance and of the comfort sought for by the user.

For this purpose, the document WO-A1-9806285 describes a protective helmet that can be adjusted to the morphology of the user's head to guarantee both protection, safety and comfort. In figures 1 and 2, the helmet 1 comprises an internal layer 3 formed by a shock-absorbing element 2 and a plurality of structures 3a to 3g fixed onto the shock-absorbing element 2 and separated into several regular parts. The helmet 1 also comprises an external layer 4 formed by a plurality of longitudinal panels 4a to 4g of

substantially identical shape and spaced apart longitudinally so to fit between the structures 3a to 3g. The panels 4a to 4g are all joined by their top edge to a top crown 5. The structures 3a to 3g are joined to the panels 4a to 4g by means of flexible joining means 6, made of flexible elastic material (figure 2). These flexible means 6 enable the structures 3a to 3g to be moved apart from one another and to vary the size of the helmet 1 when the helmet 1 is fitted on the user's head. This configuration of the helmet 1 thus enables the user to adjust the size of the helmet 1 to the morphology of his/her head.

Protection and safety are ensured by the structures 3a to 3g and the panels 4a to 4g, made of relatively rigid materials. Adjustment to the morphology of the user's head is achieved by the flexible joining means 6, formed by pieces of flexible elastic textile joining the structures 3a to 3g to the panels 4a to 4g.

Deformation of the helmet 1 is however not optimum. The panels 4a to 4g are in fact all longitudinal (figure 1). Deformation thereof is therefore regular over the whole circumference of the helmet 1. This deformation is stressed by the flexible joining means 6, which generate a flexible return phenomenon of the panels 4a to 4g on the structures 3a to 3g. The flexible joining means 6 urge the panels 4a to 4g to their rest position and cause a compression effect at the level of the head. The user is then liable to suffer from headaches after prolonged use of the helmet 1. Adjustment to the morphology of the head is therefore not optimum. Comfort also remains problematic as the shock-absorbing element 2 is joined to the panels 4a to 4g by means of the structures 3a to 3g. The relative deformations of the panels 4a to 4g and of the structures 3a to 3g are therefore dependent.

The structure of this helmet 1 generates, in addition, problems of space occupation, in particular in storage mode, as the panels 4a to 4g, joined to the top crown 5, are rigid and can hardly be folded.

Moreover, the documents DE 199 36 368 and US 3208080 each describe a protective helmet having a large number of small shell segments arranged over the whole external layer of the helmet. Furthermore, in the document DE 199 36 368, the helmet comprises a system of cords inserted in its internal layer to adjust the size of the helmet according to the size of the user's head.

However, the structures of these helmets prove relatively uncomfortable, and the adjustment system described by the document DE 199 36 368 is not efficient and is too complex to implement.

Object of the invention

The object of the invention is to remedy these shortcomings and to provide a protective helmet able to be adjusted to different head morphologies, and enabling the comfort and protection of a user to be optimized.

According to the invention, this object is achieved by a helmet according to the appended claims and, more particularly, by the fact that the shell segments and the flexible joining means are joined to the foam liner, in such a way as to enable a slight sliding between the foam liner and at least a part of the shell segments.

Brief description of the drawings

Other advantages and features will become more clearly apparent from the following description of particular embodiments of the invention given as non-restrictive examples only and represented in the accompanying drawings, in which:

Figure 1 represents a protective helmet according to the prior art.

Figure 2 represents a cross-sectional view of the helmet according to figure 1.

Figure 3 and 4 represent two perspective views of an embodiment of a protective helmet according to the invention.

Figures 5 and 6 schematically represent two exploded perspective views of an alternative embodiment of a protective helmet according to the invention.

Figure 7 represents a perspective view of the helmet without the cap according to figures 3 and 4.

Figure 8 represents a perspective view of the foam liner of the helmet according to figures 3, 4 and 7.

Figures 9 and 10 schematically represent two embodiments of a headband adjustment means of two alternative embodiments of a protective helmet according to the invention.

Figure 11 schematically represents a cross-sectional view of a part of the structure of the helmet according to figures 3, 4 and 7 to 10.

Figure 12 schematically represents a cross-sectional view of a part of the structure of an alternative embodiment of a helmet according to the invention.

Figure 13 schematically represents a cross-sectional view of a part of the structure of an alternative embodiment of a protective helmet according to the invention.

Figure 14 schematically represents a cross-sectional view of a part of a cap of an alternative embodiment of a helmet according to the invention.

Figures 15 to 18 schematically represent a part of the structure of several alternative embodiments of a protective helmet according to the invention.

Description of particular embodiments

In figures 3 and 4, a helmet 1 comprises an internal layer formed by a deformable foam liner 7, flexible joining means formed, for example, by a cap

8, and an external layer formed by a plurality of rigid shell segments 9. The shell segments 9 are fixedly secured to the cap 8 and are articulated with respect to one another by means of the cap 8. The cap 8, preferably made of flexible material of textile or elastomer nature, covers the foam liner 7 and ensures articulation between the shell segments 9. The shell segments 9 are fixed and arranged on the cap 8 in such a way as to form a crown segment 9a, an occipital segment 9b, four transverse side segments 9c, and a front segment 9d. In the particular embodiment of the helmet 1 represented in figure 3, the different shell segments 9 are not joined and are separated from one another by gaps 10. These separating gaps 10 enable a very flexible articulation of the shell segments 9, when the helmet 1 is fitted on the user's head.

The cap 8 is joined to the foam liner 7 in such a way as to allow a slight sliding between the foam liner 7 and a part of the shell segments 9, when the helmet 1 is shaped on a user's head. The join between the foam liner 7 and the cap 8 is achieved, for example, by a seam of the cap 8, which envelopes the foam liner 7 along the whole of the edge of the helmet 1. This configuration thus allows a slight sliding between the foam liner 7 and the cap 8, which bears and articulates the shell segments 9. The flexibility of the whole of the helmet 1 is preserved, and this slight sliding enables easy deformation of the helmet 1, when the helmet 1 is fitted on the user's head.

An alternative embodiment consists in achieving the join between the foam liner 7 and the cap 8 by sticking the foam liner 7 and cap 8 under the crown segment 9a. The crown segment 9a is then fixed onto the foam liner 7, whereas the front segment 9d, the occipital segment 9b and the transverse side segments 9c form "the headband" of the helmet 1 and are designed to perform the slight sliding with respect to the foam liner 7, when the helmet 1 is fitted on the user's head.

The shell segments 9 are rigid and preferably made of shock-resistant material. The material chosen must preferably be sufficiently rigid to distribute the impact of the shocks over the whole of the foam liner 7. The material is chosen for example from a polycarbonate (PC), a copolymer formed from acrylonitrile, butadiene and styrene (noted ABS), a long fibres thermoplastic or thermosetting matrix composite, or even aluminium. The thickness of the shell segments 9 is preferably about 1mm to 3mm.

The shell segments 9 are manufactured by methods known in industry, in particular by injection, thermoforming, compression or drawing. For example, it is possible to inject the crown segment 9a directly on the cap 8 and to stick or weld the other segments 9 onto the cap 8. It is also possible to weld, stitch or even stick all the shell segments 9, or a part of the shell segments 9, in the same way.

In the alternative embodiment represented in figures 5 and 6, the protective helmet 1 differs from the previous embodiment by the shape of the shell segments 9. These shell segments can comprise edges 19, with a thickness smaller than or equal to that of the shell segments 9, designed to block off the separating gaps 10 between the shell segments 9 to prevent any penetration of a sharp object and to enhance the user's safety. For example, the edges 19 are superposed above or below the adjacent shell segments 9 with which they cooperate, so as to optimize the user's safety. In figures 5 and 6, the transverse side segments 9c comprise edges 19c designed to cooperate with the crown segment 9a and the occipital segment 9b, the front segment 9d comprises an edge 19d designed to cooperate with the crown segment 9a and a part of the transverse side segments 9c, and the occipital segment 9b comprises an edge 19b designed to cooperate with the crown segment 9a.

In another alternative embodiment, not represented, the shell segments 9 are thermoformed in a single plate so as to form a single shell covering the foam liner 7 completely, with zones of large thickness constituting the shell segments 9 and zones of small thickness constituting small material bridging parts joining the shell segments 9. The thinner zones form hinges for articulation of the shell segments 9 and enable the different safety criteria to be complied with, in particular concerning the cone penetration test imposed notably by the standard EN1077.

In the particular embodiment of figures 3 to 6, the cap 8 is made of textile or elastomer. It is preferably perforated to enhance airing. The cap 8 is preferably made from an anti-perforation textile improving airing, of the high tenacity polyester type.

In the particular case of a flexible and elastic cap 8, the elasticity must be limited to avoid the shell segments 9 being spaced too far apart and the shell segments 9 and cap 8 possibly coming loose from one another. This feature is important, in particular in the case of a helmet subjected to an impact from a sharp object, to protect the user in compliance with the standard EN1077 for skiing helmets.

As represented in figures 3, 4 and 7, 8, the helmet 1 advantageously comprises attachment straps 12 securedly fixed to the cap 8. The helmet 1 comprises a chinstrap 12a and a harnessing strap 12b. In figure 6, the harnessing strap 12b surrounds the foam liner 7 via the top and rear, to ensure a good safety and a good resistance against loosening. The chinstrap 12a and harnessing strap 12b are for example stitched or riveted onto the cap 8.

The foam liner 7 illustrated in figures 7 and 8 is made of a semi-rigid alveolate material, absorbing the energy of compression shocks, and

deformable in flexion by its material and its geometry so as to fit the shape of the user's head to the maximum when the helmet 1 is put on. The helmet 1 thus behaves as a genuine deformable protective shell.

The foam liner 7 is manufactured for example by flat cutting from a sheet of polymer foam, for example expanded polypropylene. The foam is calibrated in thickness, about 15mm to 30mm, and in density, about 60 g/l to 100g/l. The shock-absorbing properties of this type of foam present a memory effect enabling it to return to its initial shape after a shock. The foam liner 7 returns to its initial shape after an impact on the helmet 1.

The foam liner 7 advantageously comprises a plurality of cut-outs 11 over the thickness of the wall of the foam liner 7. The cut-outs 11 are preferably offset with respect to the gaps 10 separating the shell segments 9, notably for safety reasons and to prevent any penetration of sharp objects. The main function of the cut-outs 11 is to foster deformation of the foam liner 7 when the helmet 1 is fitted on the user's head. They also enable a good circulation of the air collected by air vents 15 provided in the crown segment 9a (figures 3 and 7). The vents 15 are in fact preferably located facing the cut-outs 11 of the foam liner 7 (figure 7).

As represented in figures 4, 7, 9 and 10, the helmet 1 advantageously comprises a headband adjustment means 14, designed to adjust the size of the helmet 1 and to better distribute the tightness at the level of the user's headband, to optimize his/her comfort. The adjustment means 14 is preferably inserted in the occipital segment 9b and enables all the shell segments 9 constituting the headband of the helmet 1, i.e. the occipital segment 9b, the front segment 9d and a part of the transverse side segments 9c, to be moved towards one another. For example, as represented in figures 4 and 7, the adjustment means 14 is formed by a quick attachment strip, or a

self-gripping strip, joining the occipital segment 9b and two transverse side segments 9c.

In the alternative embodiment of the adjustment means 14 represented in figure 9, adjustment is performed by means of a multidirectional lacing system. The adjustment means 14 comprises a lace 20 wound around a knurled knob 21 preferably fixed on the occipital segment 9b. The lace 20 links the shell segments 9 forming the headband of the helmet 1 to one another, passing via tightening points 22, preferably arranged on the edges of the shell segments 9. Operation of the adjustment means 14 consists in actuating the knurled knob 21, for example in the clockwise direction to tighten the helmet 1, and in the counterclockwise direction to loosen the helmet 1. This type of tightening enables the headband and the depth of the helmet 1 to be adjusted simultaneously.

In another alternative embodiment represented in figure 10, adjustment is performed by means of a rack and pinion system. The adjustment means 14 comprises a tab 23, equipped with a plurality of teeth 24 forming a rack, designed to cooperate with a pinion 25 preferably fixed on the occipital segment 9b. The tab 23 is formed, for example, in the extension of a side segment 9c and is inserted in the pinion 25 of the occipital segment 9b to move the segments 9 forming the headband of the helmet 1 towards one another. Operation of the adjustment means 14 consists in making the teeth 24 slide into the pinion 25 to tighten the helmet 1, and in pressing on two buttons 26 of the pinion 25 to release the tab 23 and loosen the helmet 1.

In figure 11, the arrangement of the three layers, i.e. the foam liner 7, cap 8 and shell segments 9, is represented. The cap 8 covers the foam liner 7 completely, and the cut-outs 11 of the foam liner 7 are offset with respect to the gaps 10 separating the shell segments 9. The cap 8 represents the flexible link ensuring articulation between the shell segments 9. This

configuration therefore fosters the sliding sought for between the foam liner 7 and shell segments 9 to obtain optimum deformation of the helmet 1. The slight clearance between the foam liner 7 and cap 8, represented in exaggerated manner in figure 7, illustrates this possibility of sliding between the foam liner 7 and shell segments 9.

The alternative embodiment according to figure 12 differs from the previous embodiment by the shape of the foam liner 7. The foam liner 7 comprises thinned zones 16 in the thickness of the wall of the foam liner 7, so as to foster deformation of the foam liner 7. The thinned zones 16 are preferably offset with respect to the gaps 10 between the shell segments 9. This configuration of the foam liner 7 with the thinned zones 16 enables any risk of a sharp object penetrating through the helmet 1 to be prevented, substantially improving the user's safety.

An alternative embodiment represented in figure 13 consists in providing a foam liner 7 presenting a multi-layer structure. The foam liner 7 is formed by a superposition of sheets 27, presenting good compression absorption and flexion elasticity characteristics, to ensure a greater deformation aptitude of the whole of the foam liner 7, for the comfort and safety of the user. The sheets 27, preferably made of foam, can be of different nature, so as to achieve a progressive variation of the density of the foam liner 7, to foster comfort and shock absorption.

An alternative embodiment of the helmet 1, represented schematically in figure 14, differs from the previous embodiments by the shape of the cap 8. Compartments 13, in which the shell segments 9 are housed, are in this case formed on the cap 8. The shell segments 9 are free inside the compartments 13, securedly fixed to the cap 8. The compartments 13 are manufactured, on their internal face, with an identical material to that of the cap 8 and, on their external face, with a much more decorative material. The helmet 1 allows a

slight sliding between the shell segments 9 and the cap 8. Deformation of the helmet 1 is therefore optimum with a slight sliding both between the foam liner 7 and shell segments 9, and between the cap 8 and shell segments 9.

For example, this alternative embodiment enables different fabrics to be chosen for the compartments 13 covering the shell segments 9 and enables, for example, shell segments 9 presenting a rough finished state to be used. The advantage of such a solution compared with welding or sticking also lies in the use of the possibly elastic properties of the textile over the whole surface of the cap 8.

In figure 15, the alternative embodiment of the helmet 1 differs from the previous embodiments by the flexible joining means articulating the shell segments 9. The foam liner 7 is fixedly secured to the crown segment 9a and comprises the cut-outs 11 offset with respect to the separating gaps 10 between the shell segments 9. The crown segment 9a and the transverse side segments 9c are articulated with respect to one another by means of strips 17, for example made of flexible material. The strips 17 are made for example from the same fabric as that used for the cap 8 in the previous embodiments.

According to an alternative embodiment represented in figure 16, the strips 17 can be made of elastomer. The shell segments 9 are not joined and the separating gaps 10 between the shell segments 9 are filled by the elastomer forming the strips 17, which prevents any penetration of an object and enhances user safety.

In figure 17, the shell segments 9 can have a slight overlap to guarantee the anti-perforation feature of the helmet 1 and, particularly, to meet the requirements of the standard EN 1077. In this particular embodiment, the shell segments 9 are articulated by strips 17 of flexible material or of

elastomer, and overlapping of the shell segments 9 does not impair the slight sliding between the foam liner 7 and the shell segments 9, when the helmet 1 is fitted on the user's head.

Likewise, in figure 18, the helmet 1 can comprise a plurality of additional shell segments 18, fixedly secured to the foam liner 7 and arranged facing separating gaps 10 between the shell segments 9. The shell segments 9 are articulated by strips 17 of flexible material or of elastomer, arranged facing additional shell segments 18. The anti-perforation feature of the helmet 1 is then ensured.

According to another alternative embodiment (not represented), the helmet 1 advantageously comprises an external textile envelope covering the shell segments 9. This external envelope enables a helmet 1 with a much more aesthetic appearance to be obtained. For example, the external envelope can cover a part of the shell segments 9 only. It is possible, for example, to leave the crown segment 9a apparent and to cover the other segments 9b, 9c and 9d with the external envelope. This very advantageous configuration enables a multitude of possible ranges to be envisaged for the helmet 1, by varying the combinations of materials and colours of the external envelope and of the crown segment 9a.

It is in addition possible to achieve a folding version of the helmet 1. The transverse side segments 9c, occipital segment 9b and front segment 9d fold in towards the inside of the helmet 1, thus significantly reducing its overall dimensions. The helmet 1 thus becomes easier to stow away and to transport, for example in a rucksack.

The advantages procured by the helmet 1 are numerous. This deformable helmet structure enables several helmet sizes to be covered (2 to 3 sizes),

due to the flexibility of the structure, the possibility of sliding between the layers and the headband adjustment means 14.

This helmet can cover a range of sizes (for example from size 50 to size 63) with a limited number of references. In addition, it is envisageable, between two size references, to keep certain shell segments 9 (for example the crown segment 9a) and to only modify the size of the other shell segments 9. The number of toolings required for manufacturing the helmet 1 is then reduced.

The weight of the helmet 1 is greatly reduced, due to optimization of the thicknesses and of the volume of the foam liner 7. The useful thickness of the foam of the foam liner 7 is optimized to fit the shape of the head. Reducing the dead volume usually necessary to adjust the comfort enables the foam liner 7 to be placed very close to the head. The main effect is reduction of the leverage effect generated by a shock on a surface too far away from the head. The helmet 1 does not accelerate before coming up against the buffer stop formed by the user's head. The impact surface is better distributed, resulting in improved comfort and safety.

The configuration of the helmet 1 with the shell segments 9 makes for real fitting of the helmet 1, with excellent adjustment to the shape of the head, due to the relative mobility of each shell segment 9. In particular, the occipital segment 9b pressing firmly against the user's head results in a better holding of the helmet 1 and an enhanced feeling of safety. The position and the distinctive shape of the shell segments 9 and gaps 10 result in optimum deformation. In addition, the larger the number of shell segments 9, the more the user's comfort is improved.

The user does not feel any elastic return that could cause headaches, and the helmet 1 presents a reduced global volume, while remaining easy and pleasant to put on.

The helmet 1 is more aesthetic and less protuberant, as its general appearance is more like that of a cap. The helmet 1 also enables the user's field of vision to be improved, as it is closer to the head.

Providing a whole range of helmets 1 is easy on account of all the possible combinations of materials and colours for the crown segment 9a, the other shell segments 9, and the external envelope covering the shell segments 9, if applicable. This concept of a helmet 1 can be applied to provide stylistic and functional versions proper to each field of activity : water sports, cycling, biking, skating & roller skating, potholing, mountaineering, climbing, skiing, snowboarding, etc.

The invention is not limited to the different embodiments described above. As in all types of helmets, it is possible to line the inside of the helmet 1 with a draining, breathing and anti-bacterial fabric to improve the comfort of contact between the head and foam liner 7.

It is possible to segment the foam liner 7 into small pieces individually joined to the cap 8. It is also possible to create compartments in the foam liner 7 filled with foamed balls. The foam liner 7 thus formed then has a very great aptitude for deformation, due to its granular behaviour.

The shell segments 9 can be thermoformed in a single operation from a plate, then cut out with a water jet or by digitally controlled machining, and are then fixed onto the cap 8 or the strips 17.

To facilitate ventilation of the helmet 1, it is possible, in addition to the vents 15 of the crown segment 9a, to perforate the different shell segments 9 with small holes and to cover them with a very open mesh type fabric or with a

breathing membrane. Ventilation can also be performed at the level of the cap 8 or the strips 17, by choosing a very breathing textile.

It is possible to use other shapes for the shell segments 9, the cap 8 or strips 17, the structure of the helmet 1 having to allow a slight sliding between at least a part of the shell segments 9 and the foam liner 7 when the helmet 1 is fitted on the user's head, in order to optimize his/her comfort.